Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Canceled)

2. (Previously Amended) The method of claim 3, wherein the indicating step indicates a fault only where the fault repeats itself a predetermined number of times.

3. (Previously Amended) A method for detecting a fault in an electric power-assisted steering system, the method comprising the steps of:

determining a voltage vector of an electric power-assisted steering motor;

measuring a current vector of the electric power-assisted steering motor;

defining an acceptable angular relationship between the voltage vector and the current vector;

comparing an angle between the measured current vector and the determined voltage vector;

indicating a fault if the angle does not meet the acceptable angular relationship; and

detecting a rotational direction of the electric power-assisted steering motor,

wherein the defining step includes a first acceptable angular relationship for a positive motor rotational direction where the angle of the voltage vector must lead the angle of the current vector, a second acceptable angular relationship for a negative motor rotational direction where the angle of the voltage vector must lag the angle of the current vector, and a third acceptable angular relationship for a substantially zero motor rotational direction where the angles of the voltage and current vectors are substantially in-phase.

4. (Previously Amended) A method for detecting a fault in an electric power-assisted steering system, the method comprising the steps of:

determining a voltage vector of an electric power-assisted steering motor, wherein the determining step includes the substeps of measuring a voltage pulse width output from the electric power-assisted steering motor and checking the measured pulse width against a commanded pulse width;

measuring a current vector of the electric power-assisted steering motor;

defining an acceptable angular relationship between the voltage vector and the current vector;

comparing an angle between the measured current vector and the determined voltage vector; and

indicating a fault if at least one of the following occurs: the angle does not meet the acceptable angular relationship, or if a difference in the measured and commanded pulse widths exceeds a predetermined error limit.

5. (Original) The method of claim 4, wherein the measured pulse widths are used in determining the output voltage vector of the motor.

6. (Previously Amended) A method for detecting a fault in an electric power-assisted steering system, the method comprising the steps of:

determining a voltage vector of an electric power-assisted steering motor;

measuring a current vector of the electric power-assisted steering motor;

defining an acceptable angular relationship between the voltage vector and the current vector;

comparing an angle between the measured current vector and the determined voltage vector;

indicating a fault if the angle does not meet the acceptable angular relationship; and

detecting a position of the electric power-assisted steering motor,

wherein the defining step includes defining an acceptable angular relationship between the motor position and the current vector, and wherein the comparing step includes comparing an angle between the measured current vector and the detected motor position, and further comprising indicating a fault if the angle between the measured current vector and the motor position does not meet the acceptable angular relationship for the measured current vector and the motor position.

7. (Original) The method of claim 6, further comprising the step of inputting a torque direction, and wherein the defining step includes a primary acceptable angular relationship between the current vector and motor position for a positive input torque direction where the angle of the current vector must lead the motor position by a current alignment angle, and a secondary acceptable angular relationship between the current vector and motor position for a negative input torque direction where the angle of the current vector must lag the motor position by the current alignment angle.

8. (Previously Amended) A method for detecting a fault in an electric power-assisted steering system, the method comprising the steps of:

determining a voltage vector of an electric power-assisted steering motor;

measuring a current vector of the electric power-assisted steering motor, wherein the measuring step includes the substeps of measuring a torque drive current to the motor and checking the torque drive current against a commanded torque drive current;

defining an acceptable angular relationship between the voltage vector and the current vector;

comparing an angle between the measured current vector and the determined voltage vector; and

indicating a fault if at least one of the following occurs: the angle does not meet the acceptable angular relationship, or

if a difference in the measured and commanded torque drive currents exceeds a predetermined error limit.

9. (Previously Amended) The method of claim 3, wherein the method is only performed when the motor is not operating under a flux-weakened condition.

10.- 14. (Canceled)

15. (Previously Amended) A fault detection system for an electric power-assisted steering motor, the fault detection system comprising:

a voltage vector detector coupled to the motor that determines a voltage vector of the motor;

a current vector detector coupled to the motor that measures a current vector of the motor;

a processor coupled to the detectors, the processor defines an acceptable angular relationship between the voltage vector and the current vector, and inputs the voltage and current vectors from the associated detectors to compare an angle therebetween, wherein the processor indicates a fault if the angle does not meet the acceptable angular relationship; and

a motor rotational direction detector coupled between the motor and the processor,

wherein the processor further defines a first acceptable angular relationship for a positive motor rotational direction where the angle of the voltage vector must lead the angle of the current vector, a second acceptable angular relationship for a negative motor rotational direction where the angle of the voltage vector must lag the angle of the current vector, and a third acceptable angular relationship for a substantially zero motor rotational direction where the angles of the voltage and current vectors are substantially in-phase.

16. (Previously Amended) A fault detection system for an electric power-assisted steering motor, the fault detection system comprising:

a voltage vector detector coupled to the motor that determines a voltage vector of the motor, wherein the voltage vector detector operates to measures a voltage pulse width output from the motor to determine the output voltage vector;

a current vector detector coupled to the motor that measures a current vector of the motor; and

a processor coupled to the detectors, the processor defines an acceptable angular relationship between the voltage vector and the current vector, inputs the voltage and current vectors from the associated detectors to compare an angle therebetween, and indicates a fault if the angle does not meet the acceptable angular relationship, and wherein the processor further operates to check the measured pulse width against a commanded pulse width from the processor, and if a difference in the measured and commanded pulse widths exceeds a predetermined error limit, the processor indicates a fault.

17. (Previously Amended) A fault detection system for an electric power-assisted steering motor, the fault detection system comprising:

a voltage vector detector coupled to the motor that determines a voltage vector of the motor;

a current vector detector coupled to the motor that measures a current vector of the motor;

a processor coupled to the detectors, the processor defines an acceptable angular relationship between the voltage vector and the current vector, and inputs the voltage and current vectors from the associated detectors to compare an angle therebetween, wherein the processor indicates a fault if the angle does not meet the acceptable angular relationship; and

a motor position detector coupled between the motor and the processor,

wherein the processor further defines an acceptable angular relationship between the motor position and the current vector, ~~and~~ inputs the motor position and the current vector and compares an angle therebetween, and indicates a fault if the angle between the measured current vector and the motor position does not meet the acceptable angular relationship for the measured current vector and the motor position.

18. (Original) The system of claim 17, further comprising a torque directional sensor, and wherein the processor defines a primary acceptable angular relationship between the current vector and motor position for a positive directional torque from the torque sensor where the angle of the current vector must lead the motor position by a current alignment angle, and a secondary acceptable angular relationship between the current vector and motor position for a negative directional torque from the torque sensor where the angle of the current vector must lag the motor position by the current alignment angle.

19. (Previously Amended) A fault detection system for an electric power-assisted steering motor, the fault detection system comprising:

a voltage vector detector coupled to the motor that determines a voltage vector of the motor;

a current vector detector coupled to the motor that measures a current vector of the motor, wherein the current sensor includes torque detection; and

a processor coupled to the detectors, the processor defines an acceptable angular relationship between the voltage vector and the current vector, inputs the voltage and current vectors from the associated detectors to compare an angle therebetween, indicates a fault if the angle does not meet the acceptable angular relationship, and wherein the processor further inputs a detected torque from the torque detection and checks the torque drive current against a commanded torque drive current, and wherein if a difference in the measured and commanded torque drive currents exceeds a predetermined error limit, the processor indicates a fault.

20. (Previously Amended) The system of claim 15, wherein the acceptable angular relationships used in fault detection are dynamically adjustable depending on steering conditions.

21. (Currently Amended) A method for detecting a fault in an electric power-assisted steering system, the method comprising the steps of:

measuring a ~~voltage~~ pulse width of an output voltage ~~from~~ to an electric power-assisted steering motor;

comparing the measured ~~voltage~~ pulse width ~~output~~ against a commanded pulse width; and

indicating a fault if a difference in the measured and commanded pulse widths exceeds a predetermined error limit.

22. (Previously Added) The method of claim 21 further comprising the steps of:

detecting a position of the electric power-assisted steering motor;

measuring a current vector of the electric power-assisted steering motor;

defining an acceptable angular relationship between the motor position and the current vector; and

comparing an angle between the measured current vector and the detected motor position,

and wherein the step of indicating further comprises indicating a fault if the angle between the measured current vector and the motor position does not meet the acceptable angular relationship for the measured current vector and the motor position.

23. (Previously Added) The method of claim 21 further comprising the steps of:

measuring a torque drive current to the electric power-assisted steering motor; and

checking the torque drive current against a commanded torque drive current,

and wherein the step of indicating further comprises indicating a fault if a difference in the measured and commanded torque drive currents exceeds a predetermined error limit.